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OHM.

WHILST telegraphy is enriching the world, whilst millions of pounds sterling per annum are being saved to the general community by the rapid communication of commercial and political intelligence from one country to another, whilst, in fact, that annihilation of time and space, as regards communication of intelligence, which even the most conservative and unreflecting mind must now concede to be of an almost immeasurable benefit to mankind, is in full operation and extending daily, it may be interesting to any one having a moderately fair conception of the benefit derived by telegraphy, to cast a glance back on some of the earliest workers, who, though working only in the love of science, have contributed directly to this great benefit of mankind. But for scientific men, who labour in scientific work without any more selfish hope than that of seeing some day a beneficial result from their labour, or, who work with even less view of reward, and who only love science as abstract truth, and as a continual advance towards a true understanding of nature, which must ultimately be of benefit to mankind, without any regard to whether they may see the effect of their labours or not, the early career of Ohm, as compared with our present use of what Ohm patiently elaborated, is worthy of all attention. It must at present be borne in mind that although telegraphy has passed through many hands, such as Galvani, Volta, Œrsted, Ampere, Soemmering, Schilling, Steinhies, Cooke, Wheatstone, and Morse, besides hundreds of others, yet still the work of Ohm stands out in prominence on every-day work.

In land lines and instruments, and in the manufacture of cables, the laws of the galvanic circuit, as established by Ohm, are in constant use; but there is no application of Ohm's law which perhaps shows its direct importance in the present day so forcibly as the repair of a submarine cable. We might have groped on in the dark, making instruments and batteries, but we never could have repaired a submarine cable without Ohm's law.

Steamers fitted out at immense expense, with machinery and spare cable, buoys, and buoy ropes, and having on board engineers, electricians, and a host of subordinates, though ostensibly ordered about by bumptious managing directors in receipt of thousands a year, still really only obey Ohm's law. A submarine cable, we will say, is interrupted; an electrician makes his tests; these tests embrace many refinements, but still the most important of them are based entirely on Ohm's law. The distance of the fault is determined within a mile or two, often much less; a steamer properly fitted is despatched to the locality, and the cable is grappled up as near the fault as the errors of electrical and nautical observation permit; eventually the fault is cut out and fresh cable spliced in.

When we see so directly the importance of these scientific discoveries, it seems scarcely credible that when Ohm published his brilliant and masterly treatise on the laws of galvanic circuit it was received with positive contempt.

The following account of his life is given in Mr. Gaugain's translation of Ohm's treatise. The son of a locksmith, Georges-Simon Ohm was born at Erlangen, the 16th of March, 1787, and it was intended to bring him up to the same trade as his father. His father was a man who had a taste for study, and had acquired alone considerable knowledge, and he saw that this knowledge might be usefully applied in his business. He wished, therefore, that his sons should receive a certain amount of instruction, and on leaving school he caused them to follow the college course, at the same time exercising them in his craft, and giving them such notions of algebra, geometry, and physics as he himself possessed. The young men, who had the most happy dispositions, made rapid progress, and soon an accidental circumstance entirely changed their calling.

The learned mathematician Langsdorff, having learnt the extraordinary aptitude which the young apprentice locksmiths had shown, declared that there would be in them a repetition of the brothers Bernouilli, and gave them a kind of certificate which decided the father to renounce for them the trade which he wished to teach them and to devote them to a career of learning.

Undoubtedly this was a happy determination for science and for the world; yet in the midst of the troubles and disappointments which formed a great portion of the career of Georges-Simon Ohm, he must have regretted more than once the peaceful life which he could have passed in his father's unpretending workshop. Admitted at the early age of sixteen into the University of Erlangen, he quitted this establishment at the end of a year and a half, and became attached to the Gottstadt institution in the canton of Berne; he went afterwards to Neuchatel, where he gave lessons in mathematics, and then came back to Erlangen in 1811, where he became a temporary professor. Soon afterwards he was sent to the Royal School of Bamberg, the dissolution of which left him without employment. It was only in 1817 that he succeeded in obtaining a fixed and satisfactory engagement. During the thirteen years from 1804 to 1817 he lived in a state akin to downright misery, as may be judged by a few words of the preface to his "Elements of Geometry," published in 1817. He speaks in this passage *of the ice which coated his stove.*

At last, in 1817, he was named professor of mathematics to the great Jesuit college of Cologne. There, for the first time, he found leisure to devote himself to study in a systematic manner, and found himself also in possession of philosophical instruments by means of which he could submit his ideas to experiments. Thanks to the skill he had attained in the exercise of his early craft of locksmith, he soon became expert at transforming

his apparatus. He was thus enabled to follow in all its developments the system of which he had formed the idea, and succeeded in discovering the relations, until then unknown, which bind together the phenomena of the galvanic circuit. In 1826 he obtained a holiday which allowed of his coming to Berlin to attend to the publication of his work, which at last, in 1827, he brought out under the title of "The Mathematical Theory of the Galvanic Circuit."

This work, which brought him since a well-merited reputation, was for him at first only a new source of disgrace. The savants who were at the head of learning took no notice of it whatever, and the author having had occasion to call at the Government offices a little while after the publication of his work, had such a contemptuous reception, that the poor fellow, wounded to the quick under the first weight of his disappointment, considered that it was impossible, after such a reception, to retain the office he held at Cologne. Thus thrown again into private life, he led the most precarious existence, and found himself deprived of all means for continuing his researches. In 1833 the Bavarian Government withdrew him from this sad position by nominating him professor at the Polytechnic School of Nuremberg; but it was not till much later that his works began to be appreciated at their true value. It is to the Royal Society of London that the honour belongs of having revealed to the learned world their importance. In 1841 this Society decided that the Copley Medal should be awarded to Ohm, and supported the award by words which greatly increased the value of the reward. The following is the notice of the award in the report of the Council of the Royal Society:—

"The Council has awarded the Copley Medal for the present year to Dr. G. S. Ohm, of Nuremberg, for his researches into the laws of electric currents, contained in various memoirs published in 'Schneigger's Journal,' 'Poggendorf's Annalen,' and also in a separate work entitled, 'Die Galvanische Kette Mathematosch Bearbitet,' published at Berlin in the year 1827. In these works Dr. Ohm has established, for the first time, the laws of the electric circuit; a subject of vast importance, and hitherto involved in the greatest uncertainty. He has shown that the usual vague distinctions of intensity and quantity have no foundation, and that all the explanations derived from these considerations are utterly erroneous. He has demonstrated, both theoretically and experimentally, that the action of a circuit is equal to the sum of the electro-motive forces divided by the sum of the resistances, and that whatever be the nature of the current, whether voltaic or thermo-electric if this quotient be equal, the effect is the same. He has also shown the means of determining with accuracy the values of the separate resistances and electro-motive forces in the circuit. The light which these investigations have thrown on the theory of current electricity is very considerable; and although the labours of Ohm were for more than ten years neglected (Tischnu being the only author who within that time admitted and confirmed his views), within the last five years Gauss, Leng, Jacobi, Poggendorff, Henry, and many ther eminent philosophers have acknowledged the great value of his researches, and their obligations to him in conducting their own investigations. Had the works of Ohm been earlier known, and their value recognised, the industry of experimentalists would have been better rewarded. In this country, those who have had most experience in researches in which voltaic agency is concerned, have borne the strongest testimony to the assistance they have derived from this source, and to the invariable accuracy with which the observed phenomena have corresponded with the theory of Ohm. This accordance, it may be observed, is altogether independent of the particular hypothesis which may be adopted as to the origin of electro-motive force, and obtains equally, whether that force is regarded as being derived from the contact of dissimilar metals, or as referrable to chemical agency." — Report of Royal Society, vol. iv., p. 336, November 30, 1841.

From this moment Ohm's laws took place in all treatises on physics, and everywhere the author was considered one of the first philosophers of Germany.

About this time he had the direction of the Polytechnic School, and as he held also the professorship in physics, he had to work hard. Still he continued to follow up the researches which his disgrace in 1827 had so abruptly interrupted; he extended the framework, and conceived the idea of establishing a theory which was to embrace at once the phenomena of heat, light, electricity, and magnetism, and to this work he devoted the rest of his life. Unfortunately the duties he had undertaken left him little leisure, and perhaps, it must be said, he had undertaken a task which in the actual state of science then it would have been impossible to fulfil satisfactorily. However that may be, he did not live long enough to bring out the work, which he intended to publish under the title of "Documents on Molecular Physics." The first part only of this work appeared, and it is a kind of introduction, containing an exposition of the analytical methods which he proposed to use.

In 1849 Ohm left the Polytechnic School of Nuremberg, and was called to Munich as conservator of the philosophical collections. This interrupted his researches, to which he was devoted; but perhaps this is not to be regretted, as he published a very remarkable work on the "Phenomena of Interference in Crystals of One Axis."

In 1852 Ohm was charged with the professorship of experimental physics at the University of Munich. He thought it necessary to write a treatise on physics as a text book, and this work, which he had to perform in a limited time, overworked him so, that in 1854 his health gave great anxiety to his friends, and he died suddenly on the 7th of July of apoplexy.

The Dr. Lamont, from whose work M. Gaugain takes most of what we have given, gives a few details full of interest on the character of Georges-Simon Ohm. He had received from nature, says the doctor, a kind and good temper, and rare modesty, and these precious qualities formed the basis of all his relations with the world. Whenever his personal interests were at stake he gave way before opposition without a struggle, and without resentment.

The disgrace which in his early career deprived him of a fine position, throwing him back into

private life, inspired him with no aversion for men; and when, later, a merited reputation gave him an eminent position in science, the simplicity of his manners and the modesty of his claims remained always the same.

He showed always the most perfect equity in the appreciation of the merits of others. Never did he depreciate a work because the author was not amongst his friends; neither did he ever seek to exalt, beyond the proper measure, the merits of those savants with whom he was intimate. His justice and impartiality showed forth brilliantly every time that he had occasion to express an opinion, or to make a report to the Academy.

Indeed, Ohm occupied always in science, as in life, an isolated position, and this circumstance that might be thought unimportant, will appear of great value to all those that have studied a little the history of the learned world, and who know the various means by which it is possible to arrive at success. Profundity of knowledge, or its useful employment, have not always been the only titles which have been taken into consideration. In more than one case audacity, the skilful working on human foibles, the influence of cliques, have led to renown, to honours, and to fortune, men who have rendered but very moderate services.

ELECTRICITY AND RAILWAY TRAVELLING.*

It is proposed in the following paper to establish three propositions, viz.:—

1st. That railway travelling is dangerous.

2nd. That railway travelling is safe.

3rd. That the danger is potential, and the safety actual; and that the one has been converted into the other by the operations of scientific thought, and by the applications of scientific skill.

1. The first proposition is self-evident, and scarcely needs proof. No one has stood upon a station platform when an express train has rushed madly by without feeling that there was but a rivet, a bolt, or a rod between life and death. A broken tyre or a rail would hurl dozens into eternal gloom; a disordered permanent way would maim hundreds; the mistaken motion of a handle, the failure of a signal, or the transmission of erroneous instructions, would spread terror throughout the land. There is no sensation so great as that of a dreadful railway accident. It affects every one. All are travellers by railway; and natural selfishness makes us read with horror and dismay of the death of *units* in a railway train, while we pursue our breakfast with comparative calmness during the recital of *hundreds* smothered to death in a colliery explosion, or sent to eternity in a watery grave.

2. But is not the fact that, though we have just read the harrowing accounts of a dreadful collision in the north, we instantly entrust our precious bodies in a railway carriage to the south, a proof that there is also safety in railway travelling? Have we not faith in our railway managers, and is this faith evidence of safety? How many of those present have been in an accident? But, after all, ideas of safety are but relative. Compare accidents on railways with accidents in the old coaching days. Take the loss of life at sea, the accidents in the hunting field, in boating, in bathing, by lightning, &c., and compare them with those on railways.

In 1873, 17,246 persons met with violent deaths in England and Wales, which is an average of 750 per million, or 1 in 1354. The causes of these deaths are thus analysed:—

Table I.—Violent Deaths in England and Wales for the Year 1873.

Cause of Death.	No.
Injuries in mines	990
Mechanical injuries (not on railways or in mines)	6070
Chemical injuries	2784
Asphyxia	5193
Violence (unclassified)	919
Railways	1290

Some of these may be further analysed as follows:—

Table II.—Analysis of Table I.

Cause of Death.	No.
Mechanical Injuries—	
Fall from scaffold (ladder)	165
" " window	70
" downstairs	436
" in ships and boats	134
" from height	500
" in walking	93
" (not stated how)	530
" of heavy substances on	509
Horse or other animals	269
" conveyance	1250
Machinery	1132
Fight	5
Blow, &c.	124
Gunshot wounds	185
Chemical Injuries—	
Burns	1064
Scalds	701
" (drinking hot water)	59
Lightning	21
Sunstroke	96
Exposure to cold	138
Asphyxia—	
Drowned	3232
Suffocated by food	94
" bedclothes	611
Hanged, strangled, and executed	581
Murder, manslaughter, and suicide	228

Let us take accidents to railway passengers from causes within, and beyond, their own control:—

Table III.—Accidents to Railway Passengers, from Causes within and beyond their own Control.

Date.	Within own control.	Beyond own control.	Total.
1871	45	12	57
1872	127	24	151
1873	120	40	160
1874	125	86	211
Average	104	41	145

This is an average of forty-one persons killed

* On the Applications of Electricity to the Protection of Life on Railways. Abstract of a paper read before the Royal Society, February 4th, by W. H. Preece, Esq., M.R.I., M. Inst., C.E., &c.

annually from causes beyond their own control, and it shows, in fact, that the railway companies are in reality more mindful of the lives of their passengers than the passengers are of their own lives.

These latter accidents can be classified as follows:—

TABLE IV.—ACCIDENTS to RAILWAY PASSENGERS in 1874, from Causes within their own Control.

Cause of Accident.	No.
From falling between carriages and platforms.	49
Getting out of or into trains in motion ...	22
Crossing the line at stations	33
Falling down stairs at stations ... ... ,,	2
Falling out of carriages during travelling of trains	9
Other accidents	10
Total	125

This, however, is not the death-roll from all causes on all railways of the United Kingdom during the year 1874. The total number of persons recorded at the Board of Trade as having been killed was 1424. Of these 211 were passengers, and, of the remainder, 788 were officers or servants of the railway companies, or of contractors, and 425 were trespassers, or suicides, or others who met with accidents at level crossings or from miscellaneous causes.

1874 was, however, a very exceptional year, for no less than 71 passengers were killed in the three fearful accidents on the Great Western at Shipton, on the Great Eastern at Thorpe, and on the North British at Bowness Junction. Taking the following periods the proportion of passengers killed from causes beyond their own control to passenger journeys made was:—

TABLE V.—PROPORTION of PASSENGERS KILLED to JOURNEYS MADE.

3 years ending	1849	... ...	1 in 4,782,188	journeys made.
,,	1859	... ...	1 in 8,708,411	,,
,,	1869	... ...	1 in 12,941,170	,,
3 ,,	1873	... ...	1 in 20,082,660	,,

Taking the average length of each journey at 10 miles, one passenger is killed, from causes beyond his own control, for every 200,896,000 miles travelled. If a person travelled 10 hours a day at the rate of 30 miles an hour for each of the 365 days of the year he would probably be killed in 1835 years. Hence, in a relative sense, we may consider that railway travelling is safe.

3. How is this potentiality of danger converted into comparative actuality of safety? Freedom from accident depends upon the perfection of the road, of the rolling stock, of the signals, and, above all, of the men. But none of these elements are perfect. Accidents have been analysed into—

TABLE VI.—PERCENTAGE ANALYSIS of RAILWAY ACCIDENTS.

Defective permanent way	18	per cent.
,, rolling-stock	13	,,
,, signals	28	,,
,, human machinery ...	41	,,

They have also been classified as follows:—

TABLE VII.—CLASSIFICATION of RAILWAY ACCIDENTS, 1870-1-2 3 4.

1870	1871	1872	1873	1874	Nature of Accident.
9	19	21	24	18	From engines or vehicles meeting with, or leaving the rails in consequence of, obstructions, or from defects in connection with the permanent way or works.
10	22	17	23	13	From boiler explosions, failures of axles, wheels, tyres, or from other defects in the rolling-stock.
...	2	7	5	...	From trains entering stations at too great speed.
61	9	22	18	9	From collisions between engines and trains following one another on the same line of rails, excepting at junctions, stations, or sidings.
18	19	32	20	22	From collisions at junctions.
Included in the above 61	63	91	98	75	From collisions within fixed signals at stations or sidings, &c.
3	2	5	3	6	From collisions between trains, &c., meeting in opposite directions.
1	...	..	3	1	From collisions at level crossings of two railways
14	12	34	36	17	From passenger trains being wrongly run or turned into sidings, or otherwise through facing points.
6	11	9	11	7	On inclines.
9	12	8	6	...	Miscellaneous.
131	171	246	247	168	

Zeal and anxiety, the necessary evils of a state of tension due to increasing traffic; want of punctuality; late arrivals of the public; and variable weather, become an absolute source of danger. Every accident is traceable to its cause. Purely inexplicable accidents are unknown. Hence, though considerable improvements in the mode of working have been made—as are indicated in the continued progressive increase shown in ratio of killed to journeys made in Table V.—further improvements are certain. But all improvements bring their own evils, and the greatest of these is human fallibility. The body will tire, and the brain will get out of gear. Pure wilfulness, carelessness, or mischief, are extremely rare. Who does not make a mistake? 4,400,000 letters out of 967,000,000, or one in 220, find their way to the Returned Letter Office. 89,540 undelivered letters contained valuables, and bank-notes, bills, &c., the value of which alone amounted to £565,000; 337 of these had no addresses; 61,000 postage stamps were found loose in the different post-offices, and 20,000 letters were posted without any address at all.

How then is the comparative safety of railway travelling produced? By taking advantage of the lessons taught by experience, and by applying the means suggested by scientific thought and inventive skill to remedy defects. Failure has thus led to improvement. Every accident has been a lesson learnt, and bitterly have those suffered who have not profited by such writings on the wall. The particulars evidenced by each accident have been carefully and systematically recorded in the reports of the inspecting officers of the Board of Trade, and thus by recording past experience, the materials are collected for carefully generalizing the laws of railway working and for establishing a true science of steam locomotion.

Telegraphy, or the art of conveying information by certain pre-concerted signals to the ear and to the eye, is the chief aid of the railway engineer.

Thus, at every railway station, level crossing, or junction, signal posts are erected which convey to the approaching engine-driver by exposing discs, bars, or semaphore arms in different positions by day, or lamps displaying different colours by night, the fact that the line is clear for him to proceed or obstructed so that he must stop. The favourite signal by day—the survival of the fittest—is the arm, which, when at right angles, implies *danger*, and when at an angle of 45°, *safety*, and

"White means right; red means wrong;
Green means slowly go along."

teaches the young railway lad the rule of the road by night. The character of every train is indicated by its *head lights* and its presence to an approaching train by its *tail lamps*. Should thick weather prevent the sight of the signals, detonating fog signals announce the contiguity of danger. The marshalling of trains in station yards and platforms are produced by whistles and flags by day and lamps by night, all forming a species of telegraphic language between the fixed station and the moving train.

Where telegraphy is required to reach distances beyond the sphere of the ear or the eye, electricity is employed, and the electric telegraph becomes of prime and essential use, not only in regulating the traffic on double and single lines, but in securing safety. Special trains are moved about by its means, delays are remedied, breaksdown rendered harmless, runaway engines have been overtaken by its aid, passengers' luggage recovered, but, above all, irregularities are by its means rapidly announced, and the evils of unpunctuality rendered innocuous.

The greatest element of safety on railways is, however, the block system.

The block system arose out of the multiplication of trains, and the necessity for increased speed. Necessity, the mother of invention, brought it into existence.

By it trains travelling upon the same line of rails are kept apart by a certain and invariable interval of *space*, instead of by an uncertain and variable interval of *time*.

The practice under the time system is to exhibit the danger signal for five minutes, and the caution signal for five minutes more, after a train or engine has been despatched from or past any station, junction, level crossing, or siding. Trains are thus said to be kept apart by fixed periods of five minutes. and if the caution signals were properly regarded, by an interval of time even longer than that. The safety of the train is entirely the responsibility of the driver. Immunity from accident is dependent upon his keeping a clear look out. If engines ran at regular and fixed speeds, if time tables could be adhered to, if the line be not crowded with traffic, if the driver could always ensure a good view before him, if signals were near together and they were properly regarded, then a rigid interval of time might be maintained between following trains; but none of these elements of safety are constant. Fast expresses follow slow goods trains, now through a thick fog, now up a wet incline, at one moment in bright sunshine, at the next in a thick snowstorm; creeping mineral trains break down in a long interval between two stations; passengers rush in at the very last minute, detain the train, and prevent the time tables from being adhered to; trains are so frequent at some places that the five minutes' interval cannot be adhered to; obstructions to view arise from curves or cuttings, or from atmospheric causes; long lengths of line are unprotected by any signal at all, and signals themselves are too frequently neglected. Hence, the system is brimful of elements of danger, and the inexorable logic of facts has shown that the time interval is illusory and the system unsafe.

But when trains, however rapidly or slowly they may be running, however much punctuality has been infringed, however crowded with traffic the line may be, are invariably kept apart by an interval of one or two miles, collision between them becomes impossible. This is the *Block system*, which has, very improperly, been divided into two classes—the *absolute* and the *permissive*. The former is the block system proper, the latter is not a "block" system at all, but a system introduced, not to secure the safety of trains, but to increase the capacity of the line for the transmission of increasing traffic. It is, doubtless, an improvement on the time system, but it bears little affinity to the block, and should certainly not be included in the same category.

The block system is effectually carried out by means of electricity. Communication is maintained between station and station by means of bells rung by currents sent to announce the approach and departure of the trains. Permanent signals are raised and lowered, indices are moved to one position or another to indicate the presence or absence of danger, or the fact of the line being obstructed or clear. Indicators are moved to repeat back the signals made to check accuracy in working, and to render futile the errors or carelessness of the hasty or thoughtless. Safety is secured and accuracy in working is maintained by checks and by counterchecks.

The block system on single lines is additionally used to protect trains from *advancing* as well as from *succeeding* trains. Before a train is allowed to leave A the line at B is blocked in advance, and when it leaves it is blocked behind at A, so that it is thoroughly protected in both directions during the period it is running from A to B.

But apart from the protection which electricity imparts to railway travelling, and the facility it offers for adjusting and regulating the traffic, there are innumerable purposes for which the telegraph is employed to facilitate business and to secure efficiency. The distribution of correct time, the collection of spare trucks and coaches, the relief of staff, the supply of assistance in cases of accident and danger, and—not least—the reparation of the error and thoughtlessness of passengers.

It is used on some lines to establish an effective means of communication between passenger and guard; and perhaps one of its most useful applications is to record in the signal-box, before the signalman's eyes, the position of the signal arm by day and the condition of the light by night. which is hidden from his sight by the formation of the line, buildings, darkness, fog, or steam. Electric repeaters are one of the greatest elements of safety in working railways.

The operation of scientific thought has introduced many mechanical elements of safety into railway working, which are as ingenious as they are effective.

Improved permanent way, the interlocking of signals and points; the concentration of levers in well-constructed cabins; effective brake power; perfect tyre fastenings; better coupling arrangements, and superior engine and rolling-stock, have all aided to secure that simplicity in working and safety in travelling which undoubtedly exists.

But, as the principal element of danger in railway travelling consists in the fallibility of the human machine, it must not be forgotten that we owe our immunity from accident as much to the careful selection, education, and supervision of the staff and the maintenance of good discipline, as to the appliances of scientific skill. Science cannot be devoted to a nobler purpose than to the protection of human life, and the records of experience show that it has earned well-deserved laurels in rendering the dangers of railway travelling potential and its safety actual.

BLOCK SIGNALLING.

Continued from p. 35.

Before leaving Mr. Spagnoletti's system, it should be mentioned that it requires three wires to work it, viz., one for the up line, one for the down, and

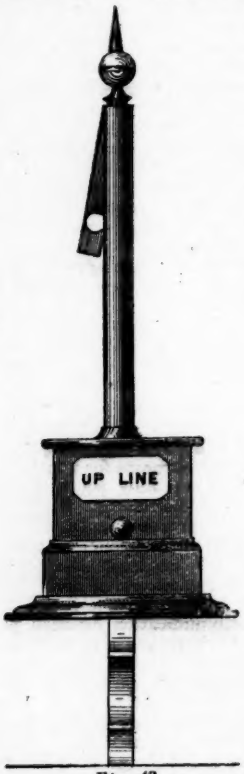


Fig. 13.

one for the bell common to both. Single-stroke bells are used, and these are worked by independent keys fitted to each bell: the tappers or keys in connection with the indicating shields are employed solely for the signals "train on line" and "line clear."

Mr. W. H. Preece is the inventor of two systems of block signal instruments, viz., a three-wire and a single-wire system. Our remarks will for the present be confined to the former.

As has been mentioned, the characteristic of these instruments is their assimilation in make and in mode of working to the outdoor signals which guide the engine-driver. In common with all three-wire systems, one wire is devoted to the up line, one to the down, and one to the bell which is common to both. Each set of instruments consists of four pieces—the semaphore, which is really the block signal, and which governs the trains, the switch, which actuates the semaphore, the bell, and the bell-key.

Fig. 17 shows the internal arrangement and electrical connections of these several parts. It represents the instruments employed at one end of

Fig. 14.

a section for regulating both up and down trains. Whilst the semaphore governs trains proceeding in one direction, the switch, which works the semaphore at the distant end of the section, governs trains travelling in the opposite direction.

Fig. 13 gives an outside front view of the semaphore with the arm sheathed or lowered to "all clear." Its internal arrangement (fig. 17) consists of a pair of electro-magnets H, a rocking lever D W, connected at one end by a wire rod R to the indicating arm, and at the other to the armature in front of the cores of the electro-magnet. This lever is pivoted at E, and is so weighted by the movable weight W, that it shall nominally—that is, when not otherwise influenced by a passing current—rest on the cock F, in which position the arm stands at "danger." On passing a current through the coils, the armature is attracted, and the lever D W raised, carrying with it the rod R, which lowers the arm to the "all clear" position. It will thus be seen that whilst the instrument is at rest, or in its normal condition, the arm is at

"danger," and the rocking lever in contact with the lower stud F, and that when a current is passing the arm is lowered and the lever in contact with the stud G.

Fig. 14 gives a front view of the bell, which is also shown in detail in fig. 17. K is an electro-magnet, M the armature, with rod O carrying the bell-hammer at its extremity; L is a magnetised needle fixed upon the spindle N, to the other extremity of which is attached a shield carrying the

Fig. 15.

Fig. 16.

words "off," "on," so arranged that when the needle L is drawn over towards one pole of the electro-magnet, as it would be, say by a negative current, the word "on" shall be brought up to the aperture in the face of the bell, whilst the armature is at the same time attracted towards the coils and a stroke struck on the bell. In like manner a positive current would carry the needle to the opposite pole, displaying the word "off" at the aperture, and at the same time striking the bell. Thus a change in the current, positive to negative or negative to positive, will produce a change in the indication—with one we shall, reading from the outside of the bell, have "Down signal 'on' at Silvertown," and with the other "Down signal 'off' at Silvertown." Any number of currents sent will give a similar number of beats on the bell, but no change will take place in the indicator unless there is a change in the current or the direction in which the current passes through the coils. The object of the indicator is to repeat the condition, or rather the position, of the semaphore arm at the distant station. The number of beats on the bell represent certain signals—as two beats, "passenger train departure"; three beats, "all clear," &c.

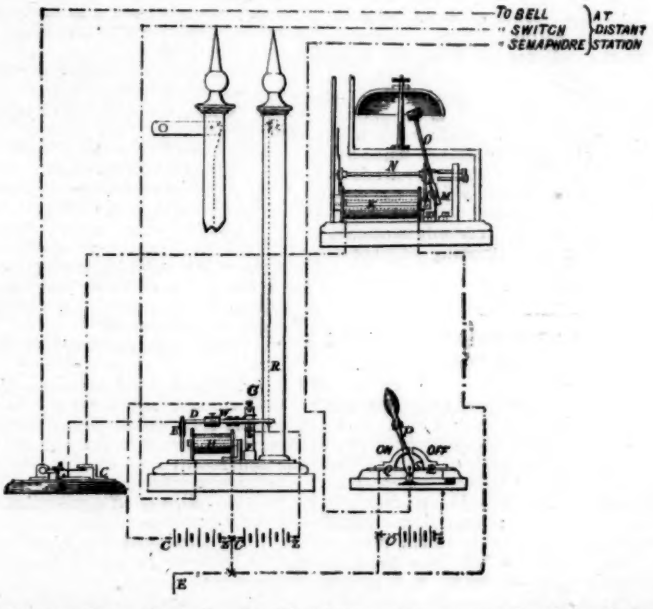
The switch is shown in front view in Fig 15, and in side section in fig. 17. The lever or handle P is arranged to move freely upon its centre S, but is provided at its lower extremity with a small steel roller for traversing a spring with a double inclined plane, the object of which is to keep it (the lever) in whichever position it may be placed, whether in the direction of "on" or "off." The semicircular piece Q R is divided in the centre, and each portion so slotted as to admit of the handle moving within it to the angle represented in the figure. The handle is provided with springs, which on either side press firmly against the segments Q, R, so as to make good contact therewith.

Fig. 16 represents the front view of the bell-key. A (Fig. 17) is a strong lever, free to move between the stop-pieces B C, but held in contact with the latter when at rest by the spiral spring placed below it. It is only on pressing the knob (fig. 16) of the bell-key that the lever A is brought into contact with the lower contact B.

The electrical connections are clearly shown in the diagram.

The line wire from the bell at the distant station

Fig. 17.



joins the bell-key at A, and is there in contact with the stud C; thence it proceeds to the coils of the bell and to earth.

The line wire from the switch at the same station is merely in connection with the coils of the semaphore, whence it goes to earth.

The wire from the distant semaphore joins the switch at its lever P, and through it is either brought into circuit with the battery attached to the segment R, or put to earth through Q.

The battery arrangement consists of one set in connection with the R or "off" segment of the switch, and two sets in connection with the semaphore, the zinc or negative pole of one set being connected to the contact F, and the copper or positive pole of the other set being connected with the upper contact G.

If now the method of signalling a train be followed, some idea of the action of the several portions of the instrument will readily be obtained. Suppose, then, an up train about to proceed from the station at which the instruments shown in the diagram are fixed. The first operation will be to *warn* the distant station—*i.e.*, the next station or signal box in the direction in which the train is about to proceed—that a train is about to start. To do this, twice two beats on the bell are given. We press the knob of the bell-key twice, then give a slight pause, and then press the key again twice. This gives in all four beats, but the pause between the second and third constitutes it a different signal from four beats given at regular intervals. Such is the warning signal. In pressing the knob of the bell-key we bring the lever A of the bell-key into contact with the lower stud B; this is in electrical circuit with the rocking lever D W of the semaphore, and it is in contact with the stud F, which is in electrical circuit with the negative pole of the semaphore batteries. Thus in the depression of A a zinc ourrent flows along the bell wire, sounding the bell at the next station, and carrying its indicator over to "on;" and to send the twice two beats it is only necessary to press the bell-key a corresponding number of times.

(To be Continued.)

MESSRS. SIEMENS BROTHERS AND THE EASTERN TELEGRAPH COMPANIES.

In the last number of the Journal reference was made to a circular which had been addressed by Messrs. Siemens Brothers to the Shareholders of the Eastern Telegraph Companies. The subject of this circular was discussed at the meeting of the Eastern Telegraph Company held on the 30th December last; and certain assertions would appear to have been then made which Messrs. Siemens Brothers regard as injurious to their reputation as cable manufacturers, and at the same time likely to throw discredit upon their previous statements. They have, therefore, issued a second letter for the purpose of vindicating their position, and they limit their reply to the two principal points which were raised. The first point refers to the following remarks made by the Chairman and Sir James Anderson:—

"If Messrs. Siemens wished to satisfy our "Shareholders that they were right, it would be "better if they, instead of trying to pick faults "in our cables, had shown us what they had done "themselves. It is simply upon the work that "Messrs. Siemens have done that this Board has "judged them; it is also from the work the Tele-"graph Construction Company have done that "they have judged favourably of them . . . . "Sir James Anderson will probably say something "of the cables which have been constructed by "Messrs. Siemens during the last ten years . . "I will only ask them to put before the public a "statement of the work they have done, and put "forth at the same time a statement of what the "Construction Company has done, and let the "Shareholders draw their own deductions as to "whether or not the Directors are justified in the "policy which they have pursued.

"I have before me a written statement of every "cable made by Messrs. Siemens in ten years; "there are, I think, five altogether, and there is "only one, I believe, at this moment working, "namely, a small cable from the Brazil Coast to "the River Plate."

The challenge thus given has been accepted, and from the data which they have been able to collect, Messrs. Siemens Brothers draw the following conclusions, premising that although a few of the details may be only approximately correct, yet the average result is practically accurate:—

"Our firm have manufactured 4,218 miles of submarine cable, all of which are not only in good working order, but are absolutely perfect in insulation, a result which no other existing cable factory can show.

"The Construction Company (including under this name their predecessors—before 1865—the Gutta Percha Company, and Glass, Elliott, and Co.) have manufactured of

"Submarine Cable (both core and sheathing) about 39,000 miles.

"Of these there are either abandoned or interrupted about 9,800 miles.

"Or say 25 per cent.

"Taking the cables which were laid during the last ten years only, beginning 1st January, 1866, we arrive at the following result:—

"The Construction Company manufactured about 33,000 miles.

"Of these are abandoned or interrupted 4,180 miles.

"Or about 12½ per cent.

"If we omit from the last mileage of cables interrupted 1,460 miles, being the Suez-Aden section, which ceased working on the 14th November, the figures will be:—

"Cable supplied 33,000 miles.

"Cable interrupted 2,720 miles.

"Or over 8 per cent.

"If we extend our inquiries to the cables owned by the Eastern Telegraph Company, we find the following:—

"Cables owned, about 10,900 miles.

"Cables interrupted 2,280 miles.

"Or about 21 per cent.

"And if we again omit the Suez-Aden section now under repair, and only reckon the Falmouth-Lisbon section, which, according to the four last Reports of the Directors, has been under repair since 1874, the result is as follows:—

"Cables owned, about 10,900 miles.

"Cable interrupted 823 miles.
"Or about 7¾ per cent.

"We have, in the above summary, solely considered cables which have ceased working entirely, but not such as are only defective in insulation, and therefore deficient in earning power. The secrecy maintained by many Boards on this point makes it impossible to compare the electrical conditions of the various cables, whereby the standard of quality and perfection attained in their manufacture could be judged."

They then proceed to say that the 4,218 miles of cable stated to have been manufactured by their firm, were manufactured in their entirety, that is to say, both core and outer coating were made by them. Presuming that the statements referred to as having been made at the Eastern Companies meeting may have had reference to all the cables with which their firm are in any way connected, Messrs. Siemens Brothers go on to say:—

"Our firm (including under this title our predecessors Siemens, Halske, and Co.) have manufactured of submarine cables (core and sheathing) 4,218 miles.
"Made only the outer sheathing of 2,931 miles.
"Giving a total of 7,149 miles.
"Of the last-mentioned 2,931 miles, there are abandoned or interrupted 561 miles.
"Or say 7¾ per cent. of the total length of 7,149 miles.
"Taking the last ten years only—
"We have manufactured (core and sheathing) 4,218 miles.
"Made only the outer sheathing of 2,531 miles.
"Giving a total of 6,749 miles
"Of the last-mentioned 2,600 miles, there are interrupted or abandoned 161 miles.
"Or less than 2½ per cent of the total length.
"On the other hand, submarine cables manufactured by the Construction Company or their predecessors (core and sheathing), about 39,000 miles.
"Made only the core of, say 11,000 miles.
"Giving a total of 50,000 miles.
"Of these are abandoned or interrupted, about 18,000 miles.
"Or say 36 per cent."

The second point taken up is the statement made by the Chairman that:

"There was one tender which we did receive "from Messrs. Siemens for the making of the New "Zealand Cable. I will not put the figures before "you; but if we take the one cable as against the "other, and the mileage of one as against the "other, the tender of the Telegraph Construction "Company would be something like £275,000, and "the tender of Messrs. Siemens would be £263,000, "which is no very great difference. . . . I can "give you the difference in the New Zealand "cable; it is about £8 per mile—but we get a ship "worth £21,000 for £15,000."

"The price named in our tender," Messrs. Siemens Brothers say, "was £248,000, as stated in our letter, and was given for 1,293½ nautical miles, the length stated in the specification which we received. An addition which may have been made to that length after we tendered would principally affect the comparatively cheap deep-sea portion, and the increase in the amount of our tender by the Chairman is therefore a mere assumption, and cannot be accepted as correct.

"A more important consideration, however, is that two cables cannot at all be fairly compared as to price if materially differing in construction, and our tender would have shown to far greater advantage when compared with that of the other Company than might be inferred by the representation of the Chairman, if we had been asked to tender on the specification actually carried out, instead of on a specification for a deep-sea cable (the construction hitherto generally adopted), which is, we believe, of about 50 per cent. greater strength and of about 30 per cent. higher cost in the sheathing."

That "some one has blundered," either in their facts or in the conclusions which may be drawn from them, is evident; and it is to be hoped that some explanation may be forthcoming which will either reconcile statements which are apparently so contradictory in themselves, or will remove the misunderstanding which has unfortunately arisen over a point of such grave importance to everybody concerned.

Notes.

THE Scilly Isles cable is now undergoing some repairs.

We understand the South Lowestoft cable is broken.

The Eastern Telegraph Company announce the repair of their Suez-Aden Cable, thus re-establishing telegraphic communication, *via* Falmouth, with India and the Far East.

The faults were caused by the cable being chafed through on the coral reefs. That near Suez took some time to repair, in consequence of stormy weather.

We understand that the submergence of the New Zealand cable has commenced.

The traffic receipts of the Direct Spanish Telegraph Company (Limited) for January were £1,346 6s. 8d., against £1,654 os. 6d. in the corresponding period of last year. An interruption has occurred at Santander in the cable. It is expected to be repaired again immediately.

The traffic receipts of the Submarine Telegraph Company for the month of January amounted to £9,048, against £8,852 for the corresponding month of the preceding year.

The traffic receipts of the Western and Brazilian Telegraph Company (Limited) for the four weeks ending 28th ult. were £10,342 7s. 4d., as against £10,262 13s. 7d. for the corresponding period of 1875. During the four weeks just ended the Lisbon-Madeira section of the Brazilian Submarine Company was interrupted for two days.

The number of messages passing over the lines of the Cuba Submarine Telegraph Company (Limited) during the month of January was 2,588, estimated to produce £2,500, against 2,021 messages, producing £2,171, in the corresponding month of last year.

The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company (Limited) for the month of January amounted to £20,405, and to £18,924 for the corresponding period of 1875.

The traffic receipts of the Great Northern Telegraph Company for the month of January last amounted to 275,776f., against 264,359f. for the corresponding period of last year.

At the half-yearly meeting of the Anglo-American Telegraph Company, held on the 4th inst., at the Cannon Street Hotel, the report was adopted, and at their special meeting later on the same day was carried the resolution of dividing their stock into A and B, by 33,046 votes, against 9,230; or, £1,898,574 capital for the motion, against £570,936. The Company will therefore be composed of three different stocks—A Stock, B Stock, and the present Ordinary Stock, or those who do not wish to divide.

The steamer *Faraday* left Gravesend on the 4th inst. for the purpose of repairing the Direct United States Cable Company's Nova Scotia New Hampshire cable. The company's traffic is at present carried by cable to Torbay, and thence by land lines to all parts of the United States and the Dominion of Canada.

A rumour is current that telegraphic communication will be opened between Teheran and Meshed; that along the line, in order to insure its protection from Turcoman raids, small garrisons will be stationed.

The *Telegrapher* says:—"A successful experiment with Gray's harmonic system of multiplex telegraphy was made at Milwaukie, Wis., on the 8th. A loop was arranged by way of Horicon to Portage, and back by way of Watertown, a distance of 200 miles. Over this single wire eight messages were sent and eight received at the same time. This experiment was witnessed by a number of telegraphers and representatives of the press."

Several literary and scientific Englishmen have joined an international committee which has been formed to erect a statue of Spinoza at the Hague. Among the most prominent names are tho of Professor Bain, Professor Huxley, Mr. Herbert Spencer, Mr. G. H. Lewes, Professor Jowett, Mr. Max Müller, and Principal Tulloch, of St. Andrew's.

Those who are in the habit of writing letters to any extent, whether in respect of home or foreign correspondence, must sometimes feel at a loss as to the number and value of the stamps to be put upon them. Weighing balances exist in most offices and studies, no doubt; but weights get mislaid or lost, and then the writer is in a difficulty. Now, most correspondents have some money in their pockets, and this may be made a substitute for weights, if people only know how to use them for the purpose. Let it be our task to tell them. As the commonest pocket weights, bronze coins may be mentioned; they are generally at hand. At the Mint one pound weight of bronze is cut into forty-eight pence. Sixteen ounces go to the pound, and, therefore, three penny pieces go to an ounce, and for home letters three pennies in weight equal one penny stamp. One pound of bronze is, again, cut into eighty halfpence; therefore, five halfpence weigh one ounce exactly, and n the scale would show that a penny stamp was needed to carry a letter of that weight or less. Ten farthings (a coin now seldom seen) are just as good. Standard silver coins are all made at the rate of sixty-six shillings to the pound troy. Thus five shillings weigh just below the ounce, if in good condition. Ten sixpences do the same, and the half-crown weighs a trifle less than half an ounce. Here, again, are ready-made weights for postal duty. Sovereigns are within a shade of a quarter of an ounce each in weight; for foreign correspondence, then, a sovereign is just the thing. Two half-sovereigns weigh also very near the quarter ounce, and they meet the requirements of foreign letters too. If these facts be borne in mind, no one need be long in trouble about the weight and proper number of stamps to be put upon letters. To sum up briefly the foregoing, we give the following table:—

Three pennies	equal to 1 oz.	one penny postage stamp.
Five halfpennies	"	"
Ten farthings	"	"
Five shillings	"	"
One half-crown	equal to ½ oz.	one extra halfpenny stamp.
Ten sixpences	equal to 1 oz.	one penny stamp.
One sovereign	equal to ½ oz.	one foreign stamp.
Two half-sovereigns	equal to ½ oz.	"

—*The London Iron Trade Exchange.*

Watches worn by students and others in technical laboratories are often rendered useless by being magnetized by the magnets used in such places. Magnets kept in the house often create equal mischief by being laid near watches, and much time and expense are sometimes needed to demagnetise them before they can be made to work. A serious case of this kind of injury recently led Professor A. M. Mayer, of the Ste-

vens Institute of Technology, Hoboken, to experiments which resulted in a very simple method of demagnetization. The magnetized watch was laid upon a table in the neighbourhood of a common compass needle. Each hour on the face was then placed in turn before it to discover the location and intensity of the magnetism in the watch. The movement of the compass showed the north and south pole to be located, say, at the figures V and XI, while the neutral points were at VIII and II. The watch was then held in a horizontal position before a large bar magnet, the two south poles being together. A gentle tilting motion was given to it for a moment, and on trying the watch again before the compass, a sensible decrease of magnetism was observed. The process was repeated till the sensitiveness of the watch at the pole was nearly extinguished, when the same thing was tried with the north pole of the watch. After a few trials and comparisons the magnetic influence was found to be removed, and the watch readily resumed its work.—*Scribner's Monthly.*

The following remarks, made by the chairman at the recent meeting of the Eastern Telegraph Company, will be read with interest:—The chairman, in moving the adoption of the report and accounts, said the gross receipts for the six months ending the 30th of September, 1875, had been £185,251, as compared with £200,050, the receipts for the half-year ending on the 31st of March previously. The difference between these amounts might in some measure be accounted for by the breakage of the Lisbon Cable. He was afraid in the present six months the expenses in this respect would not show any decrease, but rather an increase. They had had a breakage in their Red Sea cable; they immediately sent the Chiltern to the spot, but owing to the bad weather which prevailed at the time, and a most unfortunate combination of circumstances, it was three weeks before the ship could grapple for the cable. It was found and buoyed, but owing to the bad weather, the buoys were carried away to a considerable distance. Ultimately, however, the original br ak was repaired, but that had scarcely been done when they had another break, and he believed the ship was at that moment on the spot repairing the second fracture of the cable. Last July when he spoke of the durability of the cables, he drew attention to the report of their engineer, who stated that so far as they could gather from past experience, they had great confidence in the "life" of the cables. Their engineer had reported that, with one exception, the cables showed no signs of deterioration. Almost all had increased in insulation, and those longest laid had generally improved the most, and the account of the cable which had been taken up very much confirmed what the engineer had stated at that time. They were using their best endeavours to lay the cables in the best positions they could; but, of course, they had to take the ocean as they found it. He hoped they were emerging from the series of faults which they had lately had. All the other cables were in working order, except the Lisbon cable, but here they had the advantage of a duplication. With the Red Sea cable duplicated he thought they would be able to command a very large share of the Indian traffic. The New Zealand cableships were about to lay that portion of the line. As to submarine telegraphy, they were only now gathering experience about it, and he could not say whether a cable would last 40 years or six years. As regarded the cable picked up in the Red Sea, they had heard it was as good as when it was laid down. The cost of the new cable would not, he believed, exceed £200 a mile.

In the House of Commons, on February 10, Lord J. Manners, in reply to a question from Mr. M. Henry, stated that the only reason for discontinuing the issue of telegraph cards was that the experience of upwards of three years showed conclusively that the public could not be induced to make use of them.

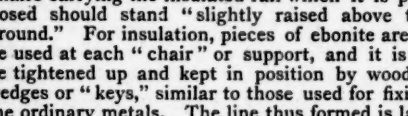
M. Albert le Bleau, chief engineer of mines at Rodez, has visited the Paris Observatory to consult regarding the organisation of the Department Meteorological Commission, of which he is president. The Commission proposes to apply the grant received from the Council-general to a thorough examination of the rainfall, the thunderstorms, and particularly the storms of hail in the different valleys of Aveyron. An anemometer is to be erected at the top of the cathedral. In developing the extremely difficult question of the issue of weather forecasts calculated to be practically useful to agriculturists, it is recognised that the essential conditions of success as regards the observers are sound sense, intimate knowledge of the physical features of the district, and shrewdness in interpreting weather signs, such as long residence in the locality alone can give; and, that it is also essential to success to carry out a minute and extensive observation of the rainfall, thunderstorms, and storms of hail within and immediately surrounding the district to which the eather-warnings a.e sent.

Reviews.

A New Method of Signalling on Railways. By Sir David Salomons, Bart. Tunbridge Wells: A K. Baldin.

"Struck by the numerous disadvantages which

"exist in the present mode of signalling on rail-"ways," Sir David Salomons has come to the rescue with a will. He proposes to make "every engine a signal in itself." To do this a third and insulated traversing rail is to be laid a quarter inch by one inch. The sleepers to which the ordinary rails are fixed might be employed for fixing the chairs carrying the insulated rail which it is proposed should stand "slightly raised above the ground." For insulation, pieces of ebonite are to be used at each "chair" or support, and it is to be tightened up and kept in position by wooden wedges or "keys," similar to those used for fixing the ordinary metals. The line thus formed is laid in blocks—that is, certain lengths, which might more properly be called block sections. Each block overlaps that following (the overlapping portion being parallel and of the same level) for a distance sufficient "to stop a train going at a very high speed." The overlapping portion is called the "battery signal line," and the other portion the "indicator signal line." Thus the parts A



A^1 to the bend or point, where it becomes a portion of the straight line, form the "indicator signal line," and the straight lines B B^1, the "battery signal line."

Under each engine are two metal wheels borne on one axis, supported by springs pressing downwards. These wheels are insulated one from the other, and the distance between them is the same as that between the "indicator" and "battery" signal lines. The train travels in the direction of the arrow, that is, from left to right of the figure. Arrived at the point where the metals overlap, the left hand wheel will traverse the "indicator" signal line while the other will roll on the "battery" signal line; but at other places the left hand wheel will be free.

"The engine carries several pieces of apparatus." Amongst these a battery and a trembling bell. "One wire from the battery" and one from the bell is carried to earth by way of the engine. The other pole of the battery is in connection with the right hand wheel, and is insulated from the engine. The second wire from the bell is in connection with the left hand wheel, and is also insulated from the engine. Now suppose a train to be traversing the overlapped portion of the insulated rail at A B, and imagine another train to be running in section 2 immediately in front of it. The "battery" wheel of the latter will be in contact with the straight portion, and the "indicator" wheel of the former with the overlapped portion of the insulated metal. Under these conditions, the insulated metal becomes a line wire, and conveys the battery current from the front engine to the bell on the rear engine, which it sets ringing, and so indicates the presence of a train in advance and within the same section.

The "indicator" is to be provided with two sets of coils, one of which is to be devoted to the battery circuit, and the other to the indicator, showing relatively the transmission of the battery current to the train in the rear, and the receipt of the current by the train in the rear from that in front. The indication is to be effected by means of different toned bells—the "needle of the indicator," in its movement to the right or left, striking the one or the other. Or the dial of the indicator may be lettered for the three indications of the needle, viz., that to the left hand "train behind," to the right hand "train in front," and when the needle is vertical "bell ringing, train behind and in front."

Sir David further proposes that each engine shall carry "a small apparatus on the same principle as the Morse itself, placed in the circuit," so that a record might be obtained of the number and time at which danger signals are received or sent, the period for which trains are kept standing at stations or in block sections, &c. By fitting the rear van with signal wheels, battery, and bell, and by providing the engine with a reversing key, communication may be had with the guard.

By the aid of an electro-magnet, which rings the bell, the steam is to be shut off and the air brakes to be put on. At crossings, sidings, and facing points, special arrangements are provided so as to prevent more than one train being within a certain distance. At junctions indicators in connection with the metals shall show the signalman on what lines trains are approaching or standing, and the signalman shall have the means of signalling to each in its turn when to come on. In cases of accident, "such as a landslip, tunnel falling in," &c., the guards are to be provided with means by which they can signal danger to all coming trains. A method is further suggested "by which every train along a line could be stopped at once." Indeed, it is difficult to determine the many valuable purposes to which the system with its "accessories" proposed by Sir David Salomons may not be extended. The proposal is not confined to a central rail system. If desirable, it is proposed to effect similar objects by means of a wire method, or signal line, consisting of a metal rail, laid "by the side of the rails on posts, 5 or 6 feet above ground," traversed by a metal brush.

It does not appear that Sir David Salomons' ideas have yet been put to a practical test, or that they have advanced beyond some models, which, although having fulfilled Sir David's expectations, will yet "bear considerable improvements." We fear Sir David will meet, should his proposal ever come to a practical test, with more difficulties than he anticipates. It is not at all clear how, should two trains be traversing the straight portion of the metal of one section at the same time, they could signal to each other, the poles of the batteries being the same. We do not think the apparatus proposed for the engine would in any measure perform the amount of work anticipated, nor would an indicator, under the influence of a make and break arrangement, such as is proposed for the bell, be found to give a sufficiently decided signal to govern a question of such vital importance. In saying this, we are ignoring the evident difficulties which would attend the laying and keeping up such an insulated conductor as is necessary for giving effect to the scheme, whether a rail or a wire. No provision appears to be made for single line working, or for trains travelling in an opposite direction on the same metals. The main objection, however, would probably be found in the principle adopted, viz., that the absence of a danger signal is *safety*. To our mind such a system, if ever worked at all, must be worked from

the very opposite principle. Safety must be conveyed by a decided and unmistakable signal, the absence of which shall, in itself, be an indication of danger.

THE "ETHERIC" FORCE.

We often hear that "there is nothing new under the sun" and a fresh confirmation of the fact will be found in a paper on the "Phenomena of Induction," by Professor Edwin J. Houston, which appears in *The Journal of the Franklin Institute* for last month. The author it appears had, as far back as the commencement of the year 1871, published an account of some experiments made by him which, both in their method and results, bear a resemblance to those recently made by Mr. Edison; and they further seem to indicate that the action of the so-called "Etheric" force, of which so much has been heard of late, was observed then, and was settled as being nothing more nor less than the effects of Electrical Induction. Professor Houston says:—

The experiments alluded to were made with a Ruhmkorff induction coil, capable of throwing the induced spark six inches in free air. I found that by connecting one of the poles of the secondary coil with a gas pipe by means of a good conducting wire, and the other pole by similar means, either with a large insulated conductor or with a semi-insulated conductor, as for example, by allowing the wire to rest on a dry lecture table, that the volume or quantity of the spark was greatly increased, and at the same time the characteristic whitening of the condensed spark produced. These results I attributed entirely to a condensation of the spark by connection with extended surfaces, similar to the condensation produced by the introduction of a Leyden battery into the circuit.

During the progress of the experiments the following facts were noted, which bear upon the observations of Mr. Edison. While the interrupter of the coil was in operation, making and breaking contact with the battery, sparks could be drawn from any metallic objects in the neighbourhood of the coil, and, indeed, in adjoining rooms. For example, by holding a small metallic object in the hands, sparks were drawn, in an adjoining room, from a large pneumatic trough, in connection by soldered joints with the water-pipes of the building. Similar sparks were drawn from a half-horse power engine, also in metallic connection with the water-pipes, and from the steam boiler in the chemical laboratory on the floor below. A person standing on the floor could draw sparks from any of the gas pipes in the adjoining rooms by holding a knife blade to the pipes or burners. These results I of course attributed to the action of the induced electricity from the coil, and published a note of them merely as a new experiment with the induction coil. On first hearing of the alleged discovery of the "Etheric Force" by Mr. Edison, I was led to think it probable that the phenomena observed by him were similar to those noticed by me in 1871, but from the brief descriptions published in the newspapers, was unwilling to make a public note of my belief. In the *N.Y. Tribune*, of December 9, however, Dr. Beard, of New York, has published a fuller account of the manner in which the experiments were conducted, and as far as I can gather they are of a similar nature to mine, and I feel warranted in believing that they can all find a satisfactory explanation by the presence of *induced electrical currents*, without the intervention of any new force whatever,

Immediately on reading the first published account of Mr. Edison's experiments, I repeated my original experiments in connection with my friend, Professor Elihu Thomson, of Philadelphia.

I append a brief description of our experiments. The induction coil already mentioned was worked by means of an electro-poin battery of ten cells coupled for an intensity of ten. The elements of each cell consist of a single plate of zinc placed between two plates of carbon. The available surface in each cell is about three by six inches. One pole of the battery was placed in metallic connection with a gas pipe and the other in similar connection with a large insulated conductor. On working the interrupting break-piece, a torrent of characteristic white sparks of condensed electricitv passed between the platinum points of the coil. Under these circumstances, that is, while the discharges were occurring between the points, sparks could be drawn from all metallic objects in the same room with the coil, or in adjoining rooms. The sparks were especially noticeable when metallic objects were approached to the gas or water pipes of the building, or to metallic surfaces in connection therewith, as in the case of the pneumatic trough, steam engines, and boiler before mentioned. As already implied, actual contact between the gas or water pipes and one of the wires leading from the coil, was unnecessary, as distinct sparks were afforded by a stove in the same room, and from another in an adjoining room.

In order to test the suspected similarity between these sparks and those described by Mr. Edison, we submitted them to the tests proposed by him. We made a number of experiments, and obtained the following general results, viz.:

First. The gold leaves of a delicate electroscope did not diverge on being brought into contact with metallic objects yielding the sparks, although in every case the sparks could be seen at the point of contact.

Second. The needle of a delicate astatic galvanometer was not sensibly deflected by the sparks, on an apparent current being caused to traverse the coils of the instrument.

Third. A small shred of cotton wool was not sensibly attracted or repelled by objects from which the spark might be obtained.

Fourth. The so-called retro-action of the spark was distinctly observed. On looping a wire back on itself, a decided spark was seen at the point of contact made by the end of the wire with any portion of the wire itself.

All the above results are in strict accordance with the known laws of electricity, as will appear hereafter.

To still further compare these results with those obtained by Mr. Edison, we dispensed with the use of the induction coil, and employed an apparatus similar to that described by him, viz.: An electro-magnet in connection with the battery already mentioned, the current of which was rendered intermittent by means of an ordinary

interrupter. With this arrangement, a wire in contact with the core of the magnet yielded sparks having all the properties described by Mr. Edison.

From a careful reading of the published accounts of Mr. Edison and Dr. Beard, it appears that the alleged discovery of a new force is based on their failure to obtain from the sparks, indications of electrical charges or currents; or in other words, in the apparent absence of electric polarity. All the effects noticed, however, are readily explainable by reference to the presence of an instantaneous outgoing current, immediately followed by an incoming one, with the complete re-establishment of electrical equilibrium. When we bear in mind the enormous velocity of electrical currents of this character, probably some hundred thousand miles per second, we can readily understand that the flow and reversion of the current would take place in an exceedingly small fraction of a second; a space of time insufficient, were the current merely direct, to produce any decided divergence of the leaves of the electroscope or the needle of the galvanometer. *The presence of the inverse current, immediately following the direct current, would absolutely and necessarily prevent the exhibition of electrical polarity as exhibited in the motion of the electroscopes, galvanometers, and of similar instruments.*

It is doubtless due to the fact that the direct and inverse currents are opposite in their effects, and therefore produce instantaneous electrical equilibrium, that Mr. Edison failed to obtain the characteristic twitching of frogs' legs, or the discoloration of iodized paper; for, although these results would nnquestionably follow an electric current in one direction, their presence would be masked by the opposite effects produced by the instantaneously following inverse current.

The possibility of the existence of the direct and inverse currents as above described, may be questioned; but when we bear in mind that the sparks can only be obtained by the interruption of the battery current, and that it is necessary to pass the battery current through a long coil of wire, conditions in every way favorable to the productions of instantaneous induced or extra currents; the direct and inverse currents follow as a matter of necessity; for the induced or extra currents in the coil of wire necessarily produce, in the core of the magnet and the metallic wire in connection therewith, an electrical current in one direction, instantaneously followed on the cessation of the induced or extra current; by a current in the opposite direction for the re-establishment of the electric equilibrium in the cores of the magnet.

It is a fact well known to all versed in electrical science that the induced current produced at the moment of making contact with the interrupter flows in the opposite direction to that produced on breaking the contact. This fact would in itself, exclusive of the above explanation, be sufficient to account for the production of inverse currents in the core of the magnet, when the interruption of the battery current was sufficiently rapid. Dr. Beard admits that the phenomena may be referred to a somewhat similar explanation, but the value he attaches to his supposition, may be judged from his subsequent adoption of the term "apolic force" as a preferable term to "etheric force."

It is matter of surprise to us that both Mr. Edison and Dr. Beard endeavored by careful insulation to eliminate in the apparatus employed by them the effects of induced electricity or induction, since it is a recognised fact in electrical science that the more perfect the insulation the more decided the effects of induction; of which, perhaps, no better instance could be found than the care taken to thoroughly insulate the secondary coils in the induction on Ruhmkorff apparatus. In view of the above considerations, we feel warranted in the belief that all the phenomena noticed by Mr. Edison and Dr. Beard are explainable by the presence of inverse electrical currents of considerable quantity, but comparatively small intensity, instantaneously produced at the making or breaking of the battery circuit.

There was noticed during the progress of our experiments with the induction coil, the following curious phenomenon, which appears to us favorable to the explanations we have adduced. One of the poles of the coil was connected with a gas pipe, and the other with an insulated conductor of considerable surface in the room containing the Ruhmkorff core. This room is in connection by a telegraph wire with the chemical laboratory on the floor below, and with an earth circuited station, D, in another building, about five hundred feet distant in a direct line. On the interrupter of the coil being worked a peculiar clicking sound was heard by both of us in the line wire in the chemical laboratory. The operator at D was requested to observe whether any unusual phenomena were noticed at his instrument. He at once telegraphed to us that a distinct "tinkling sound" was heard, which did not vary whether the ordinary battery current of the line was opened or closed. Since he did not know what to expect, his confirmation of our observation was very satisfactory. The production of the sound is probably referable to a rapid succession of molecular changes produced in the wire by the sudden reversion of its electrical states.

Proceedings of Societies.

THE CHRISTMAS LECTURES AT THE ROYAL INSTITUTION.

By PROFESSOR TYNDALL

(Continued from page 29.)

THE LEYDEN JAR AND THE ELECTRIC DISCHARGE. PROFESSOR TYNDALL'S fifth lecture on Experimental Electricity, was devoted to the Leyden jar. He began by exhibiting the first form of this apparatus, as invented by Kleist, in 1745, and Cunæus, of Leyden, in 1746—viz., a phial three parts filled with water, with a nail fixed in the cork and plunged in the water. The nail was electrified, and the charge gave a smart shock when the phial was held in one hand and the nail touched with the other. The effect was increased by Wilson in 1746, who placed the phial containing water in a vessel so filled with water as to bring the surfaces of the liquid to the same level; and by Drs. Watson and Bevis, who substituted shot for the water inside the phial. Dr. Bevis coated a plate of glass with silver-foil on both sides, within about an inch of the edge; and Dr. Watson coated a phial inside and out with silver-

foil, and thus produced the present form of the Leyden jar. The stages of the progress of the apparatus were fully illustrated by experiments; and while showing his youthful hearers how they might readily make a Leyden jar by a soda-water glass, he particularly cautioned them against cheap tumblers, the glass of which frequently contains metal, and thus they are semi-conductors instead of insulators, and nullify the results. Sir William Thompson found much difficulty in constructing his quadrant electrometer through impure glass. The principle of the Leyden jar was then explained in full accordance with electric induction. The knob of the jar is connected with the electric machine, and the interior coating is charged by it with positive electricity, which acts inductively upon the outer coating, attracting its negative and repelling its positive to the earth; and when the glass is thin and the charge is strong the attraction will perforate the glass. This principle having been demonstrated by the Professor step by step, by means of his electroscopes, he exhibited the "cascade battery" of Franklin, and explained the theory. A series of insulated Leyden jars were connected by wire—the outer coating of one with the inner coating of another. The positive electricity, which in a single jar is allowed to escape to the earth, is thus utilised, and a powerful charge is thereby obtained in each jar. Having clearly elucidated the principle, the Professor showed several simple forms of the Leyden jar, including the "hand jar." Standing upon a board placed on warmed tumblers, one of his young hearers held in his right hand a sheet of vulcanised indiarubber, and, with it between them, clasped the right hand of the Professor—the boy's left hand being placed on the prime conductor of the electric machine. When the machine was worked, the hand-jar was charged; and when their free hands were joined, a shock was felt. After stating that the charge of a Leyden jar may be sent through a great number of persons whose hands are joined, and that the physiological effects had been much exaggerated by the early electricians, Professor Tyndall produced a brilliant spark from a large machine, and then illustrated the heating effects of the electric spark. With an excited glass tube he ignited coal-gas; and with a small machine he ignited some of the volatile liquid bisulphide of carbon, the spark passing through a rod of ice held in his hand.

The Leyden Battery—The Return Shock, and Electric Heat and Light.

Professor Tyndall, in his sixth and concluding lecture, resumed his illustrations of the phenomena of electric induction by exhibiting the apparatus termed the "condenser," and showing how readily it may be made, and its action produced in a very simple way. He then repeated some of Franklin's experiments, whereby he determined the seat of the charge in the Leyden jar to be in the glass itself, and he exhibited a form of the jar in which the interior coat was movable, whereby the experiments are more easily performed. The great electric machine, so much employed by Faraday in his researches, was then adverted to, and by the aid of a battery of Leyden jars connected with this machine many striking effects were produced, of which we can only notice a few. Among them was the "back stroke," or return shock, first observed and investigated by Lord Mahon, afterwards Earl Stanhope, in 1789. Within twenty inches of the prime conductor of his machine his lordship placed a second insulated conductor, and within one-tenth of an inch from it a third conductor. When the machine was worked, a thin stream of purple sparks passed over this small interval. On stopping the machine and discharging the prime conductor, a single brilliant spark filled the space between the second and third conductor. The natural condition of the prime conductor being restored, the repelled electricity returned from the third to the second in a bright spark. With this return spark Professor Tyndall ignited gunpowder; and he stated that, in nature, disastrous effects are sometimes produced by the return shock. The earth, and those upon it, may be powerfully influenced by one end of an electric cloud. The discharge may occur at the other end, miles away; and the restoration of the electric equilibrium by the return shock may be so violent as to cause death to men or cattle. In relation to the duration of the electric spark, it was shown that in some cases it is too rapid to ignite even gunpowder; but when the current was retarded by a wet string the powder was fired. Cadogan Morgan's production of light in the interior of solid bodies was illustrated by means of an orange and a row of eggs, and on a card was shown the mark left by silver wire deflagrated by a powerful electric spark. The experiments concluded with an exhibition of the beautiful effects produced by sending the electric discharge through an exhausted double barometer-tube and several Geissler's vacuum tubes and uranium tubes. In conclusion, the Professor commented on the importance of facilitating the progress of natural science by school teachers making and using simple and cheap apparatus, and he quoted the opinion of the Duke of Devonshire's Commission, that the almost total exclusion of science from so many of our schools is "little less than a national misfortune."

PHYSICAL SOCIETY.

January 29.—Prof. Gladstone, President, in the chair.—The following candidates were elected Members: Sir J. Conroy and Mr. H. S. Burls.—The Secretary read a communication from Mr. J. A. Fleming "On the Polarization of Electrodes in Water free from Air." The experiments described were undertaken in order to meet objections which had been raised by Prof. Rowland to a previous paper by the author, in which he endeavoured to show that when an electrolyte flows in a very strong magnetic field, the electro-motive force generated by its motion affects the electrolysis of the liquid, a fact which he holds to be proved by the subsequent polarization of the electrodes.—Mr. S. P. Thompson gave a summary of the recent experiments made in America by Mr. T. Edison, Dr. Beard, Prof. Houston, and others upon the new phase of electric manifestation, the so-called etheric force. [A full account of these will be found in another column.]

ROYAL SOCIETY.

On the length of the Spark from a Battery of 600, 1,200, 1,800, and 2,400 rod-Chloride of Silver, and some Phenomena attending the discharge of 5,649 Cells. By Warren De La Rue, D.C.L., F.R.S., and Hugo W. Muller, F.R.S.

On the 24th February, 1875,* we had the honour of communicating to the Society, in conjunction with our friend, Mr. Spottiswoode, an account of some experiments to ascertain the cause of stratification in electrical discharges *in vacuo*. These experiments were made with a battery of 1,080 cells of powder-chloride of silver, which was described. We have now in action 3,240 such cells, and have recently completed 2,400 rod-chloride of silver cells,† making our total force 5,640 cells in action. To these will be shortly added another unit of 1,080 cells powder chloride, and two other units of 1,200 rod-chloride, making a total of 9,120 cells.

We have more recently made a verbal communication to the Society of Telegraph Engineers, and also in October last a written one to the Académie des Sciences of Paris,‡ wherein we have stated that the length of the spark in air appears to be in the direct ratio of the square of the number of cells.

Having completed the 2,400 cells, and charged them up in a single day, they were exactly in the same condition as to electro-motive force and internal resistance; consequently, they afforded the means of testing the truth of the law of the length of spark in a manner more efficacious than had hitherto obtained, the more especially as by the use of paraffin corks and other precautions we had obtained an excellent insulation.

Our assistant, Mr. Fram, has constructed a discharger which permits of the accurate measurement of the distance of the terminals to read $\frac{1}{1000}$ of an inch, and by estimation to the tenth of that quantity. The nut through which the screw ($\frac{1}{50}$ of an inch), carrying one of the terminals, works is divided into two parts, which are separated by a spiral pressure-spring, so as to prevent shake. In making measurements the terminals are separated to a greater quantity than the anticipated striking distance, and gradually approached until the spark passes; the discharger is then detached from the battery, and after reading the scale connected up with a separate battery of 10 cells, with a detector-galvanometer in circuit. The terminals are again approached until the motion of the galvanometer indicates contact between them; the scale is again read, and the length of spark obtained by the difference between the first and second reading.

Rod-chloride,	600 cells	had a striking	distance of	0·0033 in.
,,	1,200	,,	,,	0·0130
,,	1,800	,,	,,	0·0345
,,	2,400	,,	,,	0·0535

Taking as the unit 600 cells, the spark of which was 0·0033, the length of spark of 1,200, 1,800, 2,400 would, according to theory, be that number multiplied by the square of 2, 3, 4 respectively.

600 cells, striking distance		... 0·0033 in.
1,200	,,	0·0033 × 4 ... 0·0132
1,800	,,	0·0033 × 9 ... 0·0297
2 400	,,	0·0033 × 16 ... 0·0528

which numbers agree nearly with those obtained by experiment.

The length of the spark is much influenced by the shape of the terminals; those which we frequently employ consist of a point as one terminal and a plane for the other. Hitherto we have used copper terminals, making the point and the plane alternately positive and negative by means of a double-key discharger, or by a rapidly-revolving commutator reversing up to 352 times in a second. One terminal in the above determinations consisted of a point of 30°, and the other of a slightly convex surface 0·46 inch in diameter.

(To be Continued.)

* Proc. Roy. Soc., No. 160, 1875.
† Proc. Roy. Soc., No. 160, 1875, p. 357.
‡ 'Comptus Rendus," No. 16, p. 686, No. 17, p. 746, 1875

THE SOCIETY OF TELEGRAPH ENGINEERS. FEBRUARY 9TH.

THE Paper read was by Dr. Werner Siemens, and entitled "Contributions to the Theory of Submerging and Testing Submarine Telegraphs." Want of space compels us to defer until next number a *resumé* of it. Mr. Willoughby Smith and Mr. C. F. Varley both spoke at some length on the subject. The latter was "left speaking," and he has "the ear of the house" for the next meeting.

Correspondence.

Mr. W. LADD, of 11 and 12, Beak-street, Regent-street, writes to us as follows on the subject of "The Electro-Magnet"—"Mr. John Faulkner's electro magnet, as described by Professor Osborne Reynolds, M.A., in a paper read by him on the subject, at the Manchester Literary and Philosophical Society, an account of which appeared in the *Telegraphic Journal* on the 15th inst., cannot claim the merit of novelty. I have constructed electro magnets on this principle for the last twelve years. The following is one way in which I have applied them:—In the "Daboscy form" of electric lamp an electro-magnet is employed in connection with the clock-work which regulates the carbon point. With a small battery I found the ordinary forms of electro-magnet had not sufficient power over the keeper to obtain the necessary increase. I enclosed the electro-magnet in an iron tube, connecting it at the base with the centre tube, or bar, and surmounted the outer tube by an iron flange. This enabled the poles to act with considerable power on the keeper."

Notices to Correspondents.

E. P.—M. Breguet's address is 39, Quai de l'Horloge, Paris.

J. BARNS.—The dimensions you give would answer your purpose well. No. 16 B.W.G. wire is the best gauge to employ for a magnet of the size you give. About six layers would be sufficient. A tubular core would answer as well as a solid one, provided it be about three-eighths of an inch thick. Cast-iron is not a good metal to use for the poles, as it is magnetized with difficulty, and besides retains, like steel, a large amount of residual magnetism. The dimensions for the poles will answer well, but in any case you will require about five or six Grove's cells to get sufficient power. You do not, however, say what power is applied to the fly-wheel, and the battery-power required will be modified by it.